

SCIENCE

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THE AIM AND FUTURE OF NATURAL SCIENCE.¹

THE aim of science is twofold: we study science that we may know the truth, and that we may utilize that truth for the material and moral advantage of humanity. Of these two aims, the higher and less common is the former. Many persons will naturally inquire what advantage there can be in seeking truth for its own sake only; yet nearly all the practical applications of discovered truths have been based upon principles which have been attained, not by the so-called practical men, but by those whose lives were devoted to what has been opprobriously called the "mere getting of knowledge." It was with perhaps no slight tinge of sarcasm that Pilate exclaimed, when brought face to face with Jesus of Nazareth, "What is truth?" Nevertheless, to this question man has, from his earliest appearance upon this planet, sought for a reply; and, so long as man shall exist as man, he will never abandon his search. One form of this search is curiosity, and we call it idle; but it is far from idle in its origin. It is the insatiable desire, inborn in every man, to find out that which he does not know. It is this which led a Galileo to the torture, and a Bruno to the stake; it is this that has caused men to forsake family and friends, devoting their wealth and health, and all that the world calls happiness, to seeking truth. The little child at its mother's knee begins to imagine the why of the phenomena surrounding it; and the old man sinks into his grave, still pondering on the unsolved problems of life which he must abandon, hoping that in another world he may find the key to the mysterious hieroglyphics he leaves behind. Perhaps the origin of this desire rests on the fact that in nature itself, formed by the Almighty, we find the marks of His fingers. By studying science we are but studying His methods of working in the natural world; and thus we are like Job of old, by searching, trying to find out God. It is often lost sight of, that nature is just as true a revelation of the Deity as is the record of the Book of books; and the scientist, no less than the theologian, is a student of God and his laws. What we call natural laws are but our formulations of the method by which God has worked in nature. The study of astronomy is the study of his universe; the study of geology, the study of how he fashioned this planet; the study of evolution, but the study of God's methods of creating all living plants and animals. The time will come when religion will look back to Newton and Kepler, Dalton and Joule, Darwin and Wallace, as God's interpreters, no less truly than to Augustine and Chrysostom, Luther and Calvin, Butler and Edwards.

¹ Lecture delivered before the Polytechnic Society of Kentucky, May 26, 1890, by James Lewis Howe.

But there is another aim of the study of natural science which is to the vast majority of mankind far more practical. It consists of study for the purpose of utilizing the principles of science for the benefit of mankind. From one standpoint this aim is philanthropic, in that it seeks to use its discoveries for the comfort and convenience of mankind. This aim is hardly less worthy than that of the pursuit of science for the sake of finding truth; but in far too many instances the incentive is not any feeling of philanthropy, but merely the acquisition of personal financial gain. In the constant struggle for the "almighty dollar," Science proves herself a valuable aid, but it is only by her prostitution. In the spirit of pursuing science merely for the money it will enable one to make, the true aims of science are wholly lost sight of; and it seems often as if unhappily by far the greater number of the devotees of science are devotees merely for the money in it, like the money-changers whom Christ drove from the temple precincts. The temptation which is continually offered to leave the paths of pure science for the sake of following industrial paths is very great, and is in danger of wholly obscuring, or at least of allowing to fall into the background, the true aims of science. Of course, incidentally the human race is vastly benefited by the attainments of those who have no thought but of gain; nevertheless it cannot fail to lower science in the eyes of thinking men. Many great discoveries of the last few years have been very valuable for the world; but often, too, they have given rise to vast and grinding monopolies. It is almost alone in the sphere of medicine that the profession have kept their standard so high; and it is by them universally held that any great discovery is the property, not of its discoverer, but of all humanity. The true scientist would far rather be a Jackson or a Koller, and give to suffering mankind the wonderful alleviators of pain, ether and cocaine, than to amass millions through some patent monopoly.

Look for an instant at the vast multitude of patent-medicine advertisements which cover our fences and walls, and fill the columns especially of our religious papers. What are we to think of a man, who, if his claims be true, possesses a specific that will cure every case of consumption, or bright's disease, or some other ill of flesh with which the regular practitioner admits he is wholly unable to cope—what are we to think of such a man, when he will part with his discovery only in payment of an outrageous fee, and who will suffer hundreds and thousands to suffer and perish, in order that he may make a fortune? Is he one whit better than the physician who would allow a patient to die rather than treat him, when there was no hope of his bill being paid? The one

we call inhuman, into the coffers of the other we pour our millions. It seems to me we err when we consider any discovery of the truth whatsoever as the property of its discoverer. It is true that he who labors with the mind should receive a reward for his work, just as well as he who labors with his hand. But even our patent system does not acknowledge a man's property in his discovery: it merely gives him a monopoly of it for a few years, and then it comes into the possession of mankind, to whom it all the time belonged. There may be much fallacy mixed up with what truth there is in Edward Bellamy's "Looking Backward;" but there is no doubt but that the greed for gain is one of the darkest of the stains upon the escutcheon of our boasted nineteenth-century civilization.

Happily and naturally the great discoveries of the world have not proceeded from this avaricious spirit. As a rule, the aim has originally been solely to seek truth. It is only when the discovery has been made, that the temptation has proved too strong, and the worshipper has turned his back on the pure shrine of truth, and bowed his knee to the shrine of Mammon.

Having thus sketched briefly what appears to me the true aims of science, it is my purpose now to consider the rapid growth of science in the past, and from this, as far as it may be possible, to point out the as yet unconquered fields and the hints of what we may expect of science in the future. Down to the time of Aristotle, natural science can hardly be said to have had any existence. Here we find its dawning, when the method of deducing the law from the individual phenomena was first proposed by that far-seeing philosopher. It was, however, but the dawning, and the day was long in breaking. All through the later civilization of Rome, and through the dark ages, the advance was at a snail's pace. Alchemy recognized the true aim,—search for truth,—but to attain this aim resorted to such deception, that her lack of fidelity to the truth retarded the development of true science many centuries. Roger Bacon with prophetic vision foresaw the day that was soon to break, even as his more illustrious but infamous namesake of Verulam realized, as no other of his time, what that day would bring. Kepler, Galileo, and Newton caught the first glimpses of the rising sun, and from their time to ours the progress has been with ever accelerated velocity.

Of the four great generalizations of natural science thus far discovered, but one dates back of the present century,—that of universal gravitation. The importance of this discovery cannot be overestimated, inasmuch as this was the first time an attempt had been made to include universal phenomena under a single law. We, with our modern knowledge, are apt to underestimate the effect of thus introducing the new principle of universal generalization into science. True, Newton did not explain the cause of gravitation, nor can we. It remains for some future philosopher, some greater Newton, to show how matter can act on matter at a distance, if it does; to show us whence came that runaway star crossing the great starry disk of the universe at inconceivable speed, what force set it going, and whither it tends; to tell us why the tail of the comet is repelled by the sun, and not attracted, as all material bodies should be; to explain to us the relation existing between what we call matter and the so-called luminiferous ether. It seems to us to-day as if gravi-

tation were but a special instance of some greater, infinitely farther-reaching law, by which cohesion and chemical affinity, and a host of other phenomena to-day inexplicable, will all be made clear. Such a generalization the science of the future may hope to make.

With the opening of this century, science began to make rapid strides. The chemist of the last decades of the last century began to suspect the indestructibility of matter, and under Berzelius and Lavoisier quantitative analysis became well established. It seems strange to us to-day that such an idea as the annihilation and creation of matter could have ever been held: and yet when we think of the burning of a piece of wood or coal, with only a bit of ashes left, the other products of the combustion having vanished into thin air; when we think of the solution of a piece of iron or zinc in acid with the liquid apparently unchanged; when we think of the coating of copper formed on a knife-blade immersed in a solution of blue vitriol; when we think of how our fathers were taught that heat was a material substance which mysteriously entered into or left other substances under certain conditions,—our wonder becomes less. It remained for a Dalton to open this century with the second great generalization of science, the atomic theory of matter, which includes within itself the idea of the permanence of matter. To him all matter was made up of atoms, infinitesimal in size, unchangeable, and few in species; but by the union of the different kinds of atoms all the multiform substances which we know arise. It is true that we find the idea of the atomic constitution of matter more than hinted at in the old Greek philosophers, and some have sought to show that Democritus, and Empedocles were the real originators of the theory. But to these Greeks the atoms were but philosophic abstractions, perhaps we might better say clever guesses: to Dalton they were experimental facts. The investigations of later chemists have justified the views of Dalton, and yet have shown their incompleteness. Mendeljeff and Newlands and Victor Meyer have demonstrated the close dependence of the properties of any element on the weight of its atoms, thus enabling them to predict the properties of elements then unknown, but whose subsequent discovery has verified their predictions. Crookes has shown the probability that what we call elements in many cases may not be true elements, but mixtures of elements so closely similar that he calls them "meta" elements. Many chemists have hazarded the guess that all our elements are in reality not simple, but compounds of some one as yet undiscovered, absolutely simple element; and it remains for the chemist of the future to point out the true nature of the chemical atom.

After the time of Dalton, chemistry received an impetus greater than any it had heretofore received, by what we can characterize as the discovery of organic chemistry by Wöhler in 1828. Up to this time the existence of so called vital force had been almost universally believed in. Under the influence of this force arose all the phenomena which we call life, and which were thought to be wholly different from all other phenomena, and beyond the study of man. Substances which were formed by life it was supposed could be formed in no other way, inasmuch as life force was a force which must ever elude man's investigations. But quite by accident Wöhler formed the first organic substance from one with whose formation life had had nothing whatsoever to do. For

years the truth of his discovery was denied by philosophers; but the chemists pursued the even tenor of their ways, multiplying continually the number of organic substances artificially formed, until to-day the field of organic chemistry has manifold more investigators than that of its elder sister, inorganic chemistry. Thousands, we might say millions, of organic substances have been formed. The dye-stuffs turkey-red and indigo, as well as hundreds of the aniline dyes so called, the formation of which Dame Nature has never attempted, and many alkaloids, are chemistry's best reproductions of nature's work; and within a few months grape and fruit sugar have yielded up their secrets. Few will be the years, perhaps months, before even cane-sugar, and morphine and quinine, will be in the list of the chemist's triumphs. Indeed, there is hardly a substance which nature can form that the chemist despairs of reaching. And why not, when we consider that the same forces are at his disposal which Nature uses in her laboratory? Life is merely the director of these forces. Nevertheless we are not to consider, however great may be his attainments, that the chemist will ever form life itself. The living protoplasmic cell is something more than a complicated aggregation of complex molecules, that exists when life has left the cell; but not until we can make alive the protoplasm from which life has just departed can we hope to pass in our laboratories beyond the making of dead protoplasm.

Coming down to a date a little later than that of Wöhler, we meet the third great generalization,—that of the conservation of energy. Long after the idea of the permanence of matter had permeated science it was still believed that energy was controlled by no such law. The revolving wheel came to rest a moment after the force ceased to be applied; the rifle-bullet struck the wall, and its energy left it; the stone fell into the water, made a splash, and in a moment all was at rest (the energy in the stone had disappeared). It was only when it was realized that heat was merely a form of motion,—motion of the atom and molecule, and not of the mass,—that the conception became possible that energy, like matter, was imperishable. The wheel indeed stops, but its motion is lost by friction, and converted into heat: the molar energy has merely become molecular and atomic. The rifle-bullet has stopped, but it is hot, and the lost motion of the bullet is now making move more rapidly, and through longer paths, the molecules and atoms of the lead. The stone has fallen, but the water into which it fell has been warmed by that transference of energy; and it was Joule who showed that the heat which the water has received can be converted back into molar motion, and is just sufficient to raise the stone to the height from which it fell. Thus, while energy appears in protean forms, it is never lost; and this law we find to be no less true in the inorganic world than in the world of life. The work we do, and the heat of our bodies, are the exact equivalents of the combustion of the food we eat, with the oxygen of the air we breathe. This law has, since its discovery, formed a criterion in the judgment of the efficiency of all kinds of machinery, enabling the determination of the proportion of the energy applied as fuel or otherwise, which is utilized; and thus it further enables the saving of great amounts of energy by showing where the loss lies.

The acceptance of the fourth and last of the great gener-

alizations of science is within the memory of most of my audience. I refer, of course, to the idea of evolution. That there had been a progressive development of species of plants and animals from their first appearance on the earth, was long ago believed. It was taught in the Arabian schools during the dark ages of Europe: we even find it hinted at in the apocryphal books of the Old Testament. Lamarck tried to explain it, and Darwin's illustrious grandfather seemed imbued with the theory. Goethe was on the verge of its discovery. But it remained for Charles Darwin to so present the evidence and to explain the plausibility of its truth, that the world of science should come to believe that evolution is a fact. More, perhaps, than any of the three earlier great generalizations of which I have spoken, was that of evolution far-reaching in its influence. In little more than a quarter of a century we have seen the idea of evolution permeate the fields of history, philosophy, law, politics, philology, and even theology. It matters not in our present consideration whether or no it be a fact that man was developed from a lower form of life, whether or no life originated spontaneously from inorganic matter. These are points to be settled by evidence; and as to the evidence, scientists differ. These are but very special and minor applications of the generalization. The great idea which evolution emphasizes is that Nature does not move *per saltum*, but is uniform in her working; that God works according to what we call laws, and not arbitrarily, and that he will not suffer his highest creation, man, to be put to permanent intellectual confusion. In the application of evolution, Darwin sought to show how it was probable the development of organic nature was brought about. This does not affect the question of development of itself, which is a question of fact, to be accepted or rejected according to evidence. It has been accepted by the vast majority of all scientists; but the present work of biologists is to philosophize, as did Darwin, as to the why of evolution. He presented as chief cause the survival of the fittest in the struggle for existence; he later added sexual selection as a powerful factor; and other naturalists have proposed many other causes, more or less far-reaching in their influence.

Thus the study of evolution in the organic world to-day is a philosophy of evolution; and we may say that thus far there is comparatively little agreement among the philosophers. It remains as a great problem of the future, the solution of which perhaps none of us will see.

It is perhaps more to evolution than to any of the other great generalizations that the great progress science has made in the last quarter of a century is due; not, indeed, to its direct influence, but rather to the stimulus and impetus it has given. It perhaps might be said with truth that science has made more progress during each decade of the present century than it had made in all time previous to the opening of that decade. This is particularly true of the last ten years. While the advance here has been most largely in the realm of applied science, yet one discovery in the field of pure science ought not to be omitted, which may yet prove to be more far-reaching than we yet anticipate. I refer to the demonstration by Herz, that electricity, like heat and light, is a form of vibratory motion of what we call the luminiferous ether. To be sure, for many years it has been foreseen that this must be the case; but yet, when the dem-

onstration really comes, we are hardly prepared for the vast change in our ideas it occasions. We have been used, for the most part, to study electricity in conductors; but it now appears that this is but a special case, that we really must study electricity in the space around the conductors. Some go so far as to say that in the not distant future we shall have no more use for the words "heat" and "light," but our text-books on physics will treat in their place solely of electricity.

There is one other field of pure science to which I would like to refer this evening,—that of astronomy. When the Dutch scholar held two lenses together and saw distant objects brought near, he little thought of the revelations which would be made by the telescope of the future; he little thought of seeing the moon as if it were but ten short miles away, of viewing millions of stars where the eye sees none to shine; he little thought of seeing two miniature worlds revolving around the planet Mars,—worlds so small that we could pack several of them away in one of our Kentucky counties. It is, however, when we lend to our telescopes the aid of photography and the spectroscope that our knowledge of the universe outside of us becomes so almost infinitely enlarged.

From the spectroscope we have learned that the sun is composed of the same elements we know on our earth, that even the most distant star is but a sun like that of our solar system, that the comet is perhaps but a stream of meteors like those which our earth is continually meeting in its journey through space, that the material of all the universe is one. We learn more: for we see the genesis of worlds: nebulae condensing to suns, and suns cooling to a state like our own luminary; and yet, further, we are, as it were, in the very presence of the creation and of the death of stars,—stages our system has millions of years since passed through, and those through which it will pass centuries after we are gone.

So, too, when we find upon the photographic plate the print of stars so far away that we cannot see them even in our most powerful telescopes,—stars from which the light-vibrations which have left their impress on the plate may have started long before the first man appeared on this earth,—we feel ourselves almost in the presence of infinity itself. Is there no end to the universe, no point beyond which there do not stretch worlds on worlds? Will the science of the future answer this? Who can tell?

Turning now from the, to my audience, perhaps less familiar field of pure science, to that which cannot fail to force itself upon the attention of every one, the applications of science, we find that probably the most important single discovery is that of the steam-engine. Who could have dreamed, when that little boy sat watching the cloud of steam from his mother's tea-kettle, of the millions of applications the world was to see in the next century? Who could have imagined, when he allowed his imagination its wildest flights, that through this power civilization itself would have been revolutionized?

Ages ago the energy of the sun was stored up in the vast coal-beds of every quarter of the globe. Until the discovery of the steam-engine, man had left all this source of energy untouched. To-day he is just beginning to realize the immense capacity for work presented to him; and

yet how wasteful he is! It is for the scientist of the future to present a way that this energy can be fully utilized, since to-day, without thought for his descendants, man is scattering by far the greater portion of this energy to the air. A steam-engine which will return more than a few per cent of the possible energy of the coal is yet to be devised. Nevertheless, imperfect as the best steam-engine is, think of the improvement on the time of our grandparents! The annihilation of time and space has begun. We rush along the iron rail at a mile a minute quite as a matter of course, and a Boynton has promised us a trip from New York to San Francisco in a day; a week or less carries us across the Atlantic, and a George Francis Train needs but the time of a school-teacher's vacation to girdle the globe. Our latest journal brings us news that Jules Verne's "Twenty Thousand Leagues under the Sea" is no longer a fancy, but that the successful submarine boat has become a fact. Still More's Utopia has not yet been fully reached. The air remains as an unconquered field; but who can doubt that the time will come, and that perhaps in the not far distant future, when man will vie with the eagle in his flight, and thus friction, the great impediment to rapid transit, will be reduced to a minimum? "The birds can fly, and why can't I?" is not merely the foolish quandary of Darius Green: it is the sober inquiry of many engineers.

The advance in the field of applied chemistry is not behind that of engineering. Most striking is the cheap production of steel. From the days of the Kabyles, little advance had been made down to a comparatively recent date; but the invention of what is commonly known as Bessemer steel,—an invention, by the way, of one of our own citizens,—has opened the way to the replacing of iron by steel for a multitude of purposes, and presages the day when steel will almost completely take the place of iron. And yet prophets tell us that not steel, but aluminum, is the metal of the future. The price of this metal is continually being lowered, never more than within the past year or two; and it is certainly capable of many applications. It may be that even steel will not be able to hold its own, though I confess such is hardly my judgment.

In the field of applied chemistry is one of the best illustrations of the fact that if man can clearly state a problem, he can solve it. Napoleon offered a large reward if any one would devise a simple method of manufacturing soda from salt; and among the processes presented was one which is to-day still in use, practically unchanged in principle from Le Blanc's specifications.

With the developments of the soda industry has gone hand in hand that of soap-making. It is hard for us to believe that there could have existed a civilized people who did not use soap; but we are told the Greeks had no soap, and that the Romans used it only as a cosmetic. Still it is none the less true that, as has been said by another, it is possible to judge the standard of civilization of a nation by the amount of soap which it uses. Perhaps the two other most striking and most promising developments of applied chemistry are those of the synthetical formation of dye-stuffs and drugs.

Many of you doubtless remember the furor occasioned when the first aniline dyes were thrown on the market, and the fortunes made and lost. Yet who could have foreseen the

almost infinite number of colors which we may to-day see, especially among the silks, in a dry-goods house? The color-sense of the modern European and American has developed in a wonderful degree in the last quarter of a century; and can we doubt that "rods and cones" have either undergone a remarkable increase in number, or else have been marvelously educated? The most striking of the advances in this line was the artificial formation of alizarine, the dye-stuff known as turkey-red, and which, preserved to us still unfaded as Egyptian mummy wrappings, justifies the biblical comparison of sin to "scarlet." Indigo has been in more than one way synthetically formed; and it is certain, that, even as the alizarine manufacture has completely ended the cultivation of the madder, so it will be but a few years before the chemist will vie with nature in the manufacture of indigo. But it would seem that the industrial chemist does nothing half way. Not satisfied with imitating nature, the dye-stuff chemist has for his aim the production of colors of any wave-length or any combination of wave-lengths whatsoever, and he seems not to waver in his course toward this goal.

Salicylic acid, salol, antifebrin, sulphonal, and homatropin stand among the brilliant examples of what chemistry has done for the medical profession; but we shall look in the near future to the artificial formation of quinine and morphine, and any other drug that may be demanded. Perhaps here the field of physiological chemistry will in the future hold sway, and we may live to see the time when the drug will be manufactured directly for the purpose of meeting certain symptoms. This looks by no means impossible, in view of the recent introduction of a large and ever-increasing number of antiseptics, antipyretics, and hypnotics. When it has once been determined what is the relation existing between chemical composition and physiological effect,—and this is to-day the field in which physiological chemistry has the most to hope,—then will the time have come when not only medicine will have been rescued from the bonds of empiricism and reduced to a science, but chemistry will be acknowledged as her handmaiden, furnishing the physician that special drug which will play the specific in each individual case.

This leads us to the field of medicine and surgery. Of course, the most marked advance in this department is the general acknowledgment of the germ theory of disease. It may be that in the majority of cases the peculiar germ of the disease has eluded discovery, it may be that the germ theory is but one side of the subject of origin of disease; nevertheless it is true that medicine and surgery, under the influence of this theory, are undergoing a marvellous change, which is destined to add months and years to the average life of man. Jenner walking in the darkness, and Pasteur in the twilight of early dawn, have traced the path which our successors decades hence will follow. We must not marvel if, in the dimness of early morning vision, all is not as clear to them as it will be generations hence, but rather wonder that in the faintness of the light they could have caught the first glimpses of the coming day.

We to-day can see clearly that the task of the physician of the future will be not so much to heal disease as to prevent it; and may we not look forward to the time when every germ of consumption and scarlet fever and diphtheria,

and other kindred diseases, will have been exterminated, even as the Diornis of New Zealand and the buffalo on Western prairies? This being the case, surgery will be robbed of its terrors, and its advances in the past decades will be as nothing to what the future has in store.

If I were asked to name the subject most attracting the scientific man of to-day, I should answer electricity; if I were asked to name the field in which there is the greatest opening for a scientist, I should say electricity. When looking at this field, we are looking at a field which is hardly yet in the earliest stages of infancy. To be sure, the application of electricity to the telegraph and telephone seems to us an old story; but the developments which must follow the recent discovery of Herz of the true nature of electricity will undoubtedly bear fruit in the improvement of these instruments. When we further take into consideration the subjects of electric lighting, electric motors, and electric welding, we have every thing to hope for the future. Indeed, now that we may consider the study of electricity founded upon a solid basis, the wonders which a few decades will bring forth cannot be foretold.

And now, were I asked to suggest the great problem which is to tax the ingenuity of the scientist of the future, I should say it would be the utilization of energy. To-day we have practically going to waste the energy of the sun and wind, and wave and tide, and even that of our great cataracts. We could hardly compute the infinitesimal proportion which is utilized by the various wind-mills and tide-mills, and turbines beneath Niagara. The stored energy of the sun in the carboniferous period still mostly remains unused by us in our coal-beds, but these will eventually be exhausted. Nevertheless the sun is to-day furnishing us just as much energy as then, and it only remains for the future scientist to devise some method for its utilization; and we cannot doubt this will be done. Again, the scientist of the future will devise some method by which the energy of fuel will be converted into electricity without passing through the stages of the steam-engine and dynamo, in which by far the largest portion is lost. The energy of the combustion of zinc is converted with little loss into electricity. Who will be the man to invent a battery in which the energy of the union of carbon with oxygen will be directly converted into electricity? When, still further, we to-day take the energy of coal and convert it into steam, thence into engine motion, thence into electricity, thence through the incandescence of carbon into electric light, we do it at tremendous loss. The glow-worm and the lantern-fly effect the same transformation with scarcely a trace of heat, and, as far as we know, with little loss. One of the greatest problems of the future will be the transformation of carbon energy into light in some similar way, when a single pound of combustible material will furnish us as much light as is now obtained through illuminating-gas or the electric light from a ton of coal.

And what now shall we conclude of the future? Will the time come when by improved machinery one man's labor will clothe and feed a hundred? Will our bread and meat be made for us by the chemist from coal and water and air? Shall we traverse the earth and air and water on the wings of the lightning? Will the vagaries of Edward Bellamy become facts, and money vanish, and with it avarice

and all its accompanying vices? Will the poet's dream come true?—

“Men, my brothers, men the workers, ever reaping something new:

That which they have done but earnest of the things that they shall do:

“For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonders that would be;

“Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight dropping down with costly bales;

“Heard the heavens fill with shouting; and there rained a ghastly dew

From the nations' airy navies grappling in the eternal blue;

“Far along the world-wide whisper of the south wind rushing warm,
With the standards of the peoples plunging through the thunder-storm;

“Till the war-drum throbbed no longer, and the battle-flags were furled

In the parliament of man, the federation of the world.

“There the common sense of most shall hold a fretful realm in awe,

And the kindly earth shall slumber, lapt in universal law.”

Whether these things will be realized we know not. In view of the past, we dare not say our wildest dreams and fancies will not to-morrow be realities. But this we know: that wherever it is possible to benefit mankind, to alleviate suffering, to elevate humanity, and to raise man more nearly to the true image of his Maker, there the aid of natural science will never be found wanting.

THE SECOR SYSTEM OF MARINE PROPULSION.

FOR over four years there has been in process of development in the city of Brooklyn a system of propelling vessels which it is believed will offer distinct advantages over the marine steam-engine. The following is a brief description, condensed from “General Information Series,” No. VIII., of the United States Navy Department, for 1889:—

“The propulsion of vessels by the liberation of a large volume of gas by explosion and the displacement of water thereby has been tried, and has met with some success.

“The method employed is the invention of Mr. Secor, and is fitted to a vessel 100 feet in length, called the ‘Eureka.’

“The apparatus consists of two horizontal tubes about twenty inches in diameter, placed fore and aft in the after part of the vessel below the water-line, the after ends being in communication with the sea. Petroleum in the form of spray, and air under pressure, are injected into the tubes at the forward ends, and exploded by electricity. The disengaged gas expels the water from the tubes, and the re-action against the forward ends of the tubes propels the vessel. The explosions are arranged to take place alternately in the cylinders, and the firing mechanism to work automatically. Sixty explosions a minute in each cylinder have already been obtained, giving quite a uniform motion.”

In 1824 Sadi Carnot propounded the great principle that the useful effect of any heat-engine was independent of the nature of the working fluid, and depended solely on the extremes of temperature in the working cylinder; or, as it has been expressed, it depends on the range of temperature of the working fluid during its working cycle. Sir William Thomson determined the exact expression for this efficiency, and it was also deduced analytically by Rankine as follows:—

$$E = \frac{T' - T^2}{T'}$$

T' is the temperature above the absolute zero at which heat is supplied; and T^2 , that at which it is rejected.

In the “Encyclopædia Britannica” (edition of 1889), article “Steam-Engine,” Professor I. A. Ewing points out that in the cylinder of a gas engine the efficiency would be 87 per cent, if it were possible to expand down to atmospheric temperature and dispense with a water-jacket: thus in Centigrade temperature,

$$\frac{2173^\circ - 288^\circ}{2172^\circ} = .87 \text{ nearly.}$$

This would represent an efficiency six times greater than the most economical triple expansion steam-engine.

The conditions which are impossible in any cylinder containing a moving piston are obtainable by the Secor thermo-dynamic method. The necessity for the wasteful water jacket at once disappears. The degree of expansion with its concomitant fall of temperature is only limited by the temperature of the sea, which constitutes the thermo-dynamic cold body or refrigerator. It may be remarked that the discharged gases, consisting principally of air, nitrogen, and carbonic acid, are poor radiators of heat, thus limiting antecedent heat-waste.

The conditions of the Secor cycle are, then, an explosion or combustion at the highest temperature—the dissociation limit—within a heated chamber, from which the outflow of heat may be prevented by suitable linings, the non-radiating products of combustion expanding in re-action against the coldest medium provided by nature (the ocean); the cooling being coincident with, and not antecedent to, the mechanical effect.

Science is to-day making demands of the steam-engine which it can never satisfy. Science says, let no heat escape from smoke-stack, or radiate from boiler, steam-pipe, or cylinder; then increase the range of temperature four or five fold that of the quadruple-expansion steam-engine. Hitherto the reply of the engineer has been, that, inasmuch as no conversion of energy can occur without some loss, even 85 or 90 per cent is, after all, not too great a tribute to pay to nature.

Thurston shows that the cannon does much better, yielding nearly 50 per cent of thermo-dynamic efficiency. The electrician working in a new field, undeterred by precedent, guided only by a knowledge of the laws which relate to the conservation and correlation of energy, has accomplished still greater results. An efficiency of 90 per cent in the dynamo is one of the grandest achievements of applied science.

Although the method of propulsion in the Secor system involves a radical change as compared with the screw, it is not impossible to estimate the efficiency of an air-jet under the circumstances indicated. The limited area of a jet of air or water has been supposed to involve a great loss of efficiency. This idea has arisen principally from erroneous conceptions in respect to the screw.

It was at one time an axiom in engineering, that the larger the exposed area of the screw, the more effective would be its action. Experience has shown the fallacy of this idea. Data of the trials of three large transatlantic steamers, showing the comparative merits of large and small screws under similar conditions, are given by Arthur I. Maginnis, Esq., in a paper read before the Institution of Naval Architects. He remarks, that “by these results it will be seen that propellers of small diameter have in each case proved the most economical and effective, both increasing the speed and decreasing coal-consumption.” Mr. Isherwood has shown that decreasing the number of blades in a screw causes no falling-off in speed. Mr. Ericsson's theory was directly opposite in the early days of screw navigation. It was considered a peculiar advantage in the Ericsson screw that it had six blades. Mr. Griffiths has proved that increasing the hub area up to one-fourth the total diameter does not lessen the speed. Speaking of the tip of the blade, Mr. Barnaby says, “The tip of the blade is very little good, only you must have a tip.” The exposed area need be only sufficient to absorb the engine's power: more than this is a loss.

Not only were the early engineers mistaken in regard to area, they were equally erroneous in the theory of slip. Mr. W. Froude remarks, “that to assert that a screw works with unusually little slip is to give proof that it works with a large waste of power.” He remarks further, “Experiments which have been in progress since this paper has been in type show conclusively that the decrease of efficiency consequent on increasing slip, with screws of ordinary proportion, is scarcely perceptible.”

In 1867 the British Government built the "Water Witch," a 1200 ton vessel, to test the value of hydraulic jet-propulsion. Engineering records show that several jet steamers have been built since that date; the latest being the "Duke of Northumberland," completed in 1890 for life-saving purposes.

It is now well known that theorists were wrong in their conceptions of the efficiency of a jet. The eminent authority, Mr. S. W. Barnaby, has shown that the efficiency of the jet is 75 per cent, as against 65 per cent for the screw: in other words, it is 15 per cent better than a remarkably efficient screw. Why, then, has not the jet entirely superseded the screw? Mr. Barnaby has shown that it is due to pump inefficiency. This is a loss which may be reduced, but cannot be entirely avoided. Friction and inertia in the pump more than neutralize the enormous advantage possessed by the jet over the screw. The average pump loss is about one-half the total power.

Mr. R. H. Tucker of Boston, in 1880, tried direct-air propulsion on a canal-boat. An 8-horse-power engine drove a No. 4 Root blower, the air being discharged directly against the water astern. The Root blower has an efficiency of about 75 per cent. The result, four miles per hour, showed a good efficiency for the fuel expenditure.

As a whole, the Secor system provides those thermo-dynamic conditions which science demands, but which cannot be satisfied in a reciprocating, rotating heat-engine. In every known method of propulsion, whether paddle, screw, or jet, there is a considerable expenditure of power between the cylinder and the propeller. In the Secor system, friction and inertia of moving parts are eliminated, and, without anterior loss of heat or power, that method of propulsion is adopted which is suggested by the most advanced science.

The purpose of the present paper is to state briefly the theory of the system rather than to discuss its commercial or naval advantages. It may, however, be mentioned that a first-class transatlantic steamer carries a weight of 5,500 tons in engines, boilers, fuel, and water. To offset this permanent ballast, there is the passenger accommodation, and capacity for less than 1,000 tons of paying freight,—\$10,000 in coal, about \$600 in oil,—and 180 men are required to keep the leviathan in motion for one trip. In view of this situation, the advantages of the Secor system, in theory at least, are evident.

NOTES AND NEWS.

THE eighth congress of the American Ornithologists' Union will convene in Washington, D.C., on Tuesday, Nov. 18, at eleven o'clock A.M. The meetings will be held at the United States National Museum. The presentation of ornithological papers will form a prominent feature of the meetings; and members are earnestly requested to contribute, and to notify the secretary in advance as to the titles of their communications, so that a programme for each day may be prepared. The address of the secretary is John H. Sage, Portland, Conn.

—Platinum has long been recognized as an extremely refractory metal to use in electroplating, the difficulties mainly arising from the fact that the strength of the bath cannot be maintained, as with other metals, by using a plate of platinum as the anode, as the metal will not dissolve. The consequence is, that both the richness and conductivity of the bath are continually altering, and a satisfactory deposit can only be obtained by the most constant attention. In a recent paper on the subject which was read before the chemical section of the Franklin Institute, according to *Engineering* of Oct. 10, Mr. William H. Wahl states that it occurred to him that it might be possible to maintain the strength of the bath by greatly increasing the surface of platinum at the anode, which was accomplished in the following way: a plate of carbon was saturated with platinic chloride and dried, thus impregnating the plate with the salt, from which the platinum was finally reduced to the metallic state by heating the whole plate in a crucible. In this way a deposit of platinum in an extremely fine state of division was obtained in the pores of the carbon plate, and this plate was then used as the anode of the electrolytic bath. On passing the current, the platinum proved

to be readily soluble in a bath of hydrochloric acid, and so far the experiment was a success; but the process proved useless from a commercial point of view, as the metal still remained insoluble when the bath consisted of oxy salts of platinum, which alone give good deposits. It was therefore necessary to devise some other plan, and after many fruitless experiments Mr. Wahl claims to have succeeded by using platinum hydroxide for maintaining the strength of the metallic solution. For this purpose the salt, which is readily soluble in alkalies and in many of the acids, may be introduced into the plating bath from time to time, and dissolved therein by stirring; or it may be permitted to remain in the bath in excess, either at the bottom or suspended in a canvas bag adjacent to or surrounding the carbon anode. A weak aqueous solution of caustic soda or caustic potash, especially the latter, will dissolve a large quantity of platinum hydrate; and the solution has the advantage of being freely conductive of electricity, and of yielding bright, regular, and adherent deposits of platinum on electrolysis. Further, with currents of moderate strength, the platinum hydrate only is affected; and hence the constitution of the bath can be easily maintained constant by adding fresh supplies of platinic hydrate. Other solvents have also been tested by Mr. Wahl, but for these details we must refer our readers to his paper, contenting ourselves with giving the main outlines of his discovery.

—The United States Coast and Geodetic Survey Office has received from the Government Printing Office Appendices Nos. 12 and 13 to the "Report of the Superintendent for 1888," in pamphlet form. Their titles are "No. 12. Hypsometry: Heights from Geodetic Levelling between Arkansas City, on the Mississippi River, and Little Rock, Ark., 1887-88 (field-work by J. E. McGrath, sub-assistant; reduction by C. A. Schott, assistant)," "No. 13. Astronomy: Differential Method of computing Star Places," by E. D. Preston, assistant. The levelling-work in Arkansas was continued in 1889 by Sub-Assistant Isaac Winston, who ran the line from Little Rock, Ark., to Fort Smith, Ark. Mr. Winston will probably extend the same work during the coming season, beginning at Fort Smith, Ark., and running northward toward Kansas City, Mo., where eventually this line will be connected with the main transcontinental line of levels. The results that are now being obtained are immediately utilized by the Arkansas Geological Survey and others.

—A meeting of a committee of Harvard students has been held to consider the best means of raising a fund for building a new library reading-room. For several years students and instructors alike have felt the need of such a room, capable of being lighted and open in the evening. Two years ago a petition signed by nearly every student of the university was presented to the corporation, asking to have Gore Hall lighted by electricity. The corporation deemed this unsafe, since the present building is not fire proof; and impossible, since they had not the funds necessary to make it fire-proof. To a letter asking what the cost of such a reading room would be, the president replied, "A proper reading-room attached to the present library building would cost from \$100,000 to \$200,000, according to its size and general style. A plain stone building of sufficient size, made fire-proof and lighted with electricity, could hardly be built and furnished for less than \$100,000. If the design were elaborate and handsome, as well as sufficiently spacious, it could not be built for that sum." Ill ventilation, bad light, and early closing of the library, together with the feeling that no remedy was forthcoming, brought the matter forcibly before the students. The committee above referred to considered the advisability of taking active steps in the matter, and voted to make a canvas of the college in order to raise as large a portion of the fund as possible among the students themselves, and then, by a circular letter, to appeal to the alumni for the rest. Accordingly the college has been canvassed; and, notwithstanding the many demands upon the students for money consequent upon the opening of a new college-year, 789 men have already contributed \$3,530, or \$4.40 per man. According to the last quinquennial catalogue, there are about 5,500 living graduates of the college proper. It is to be hoped that from so large a number at least \$150,000 will be speedily forthcoming.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

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LETTERS TO THE EDITOR.

* * * Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

Fluctuations of Air-Pressure.

It is probable that no problem in meteorology has been so puzzling as the explanation of the diurnal range of the barometer. This phenomenon is one of the most constant in meteorology; and, in fact, it is so regular near the equator, that Humboldt once said he could tell the time of day in that region by reading his barometer. On examining a barograph trace made in the tropics, we find a most surprising regularity both in the maximum and minimum points of the curve day after day, and also in the amplitude of the range. These conditions, however, do not exist in the temperate regions or in those farther north. Here there is superposed upon the diurnal range a mixed fluctuation, due in the main, if not entirely, to the passage of areas of high and low pressure. These areas are continually passing, and in consequence the diurnal range is masked, or even entirely obliterated on some days. It is known, however, that in general the diurnal range is much increased on bright, sunshiny days. Gen. Greely found a trace of this range at Fort Conger, 81° 44' north. It is known that the range has two maximum and two minimum points. The principal maximum occurs all over the globe between 9.30 and 11 A.M.,

and the principal minimum from 2.30 to 4 P.M. The two other points occur approximately at the hours of the same name at night. This remarkable fluctuation is observed at the tops of high mountains, showing that the cause is above the lower atmosphere. The voyages of the "Challenger" and of other vessels have shown that this range is the same over the ocean as on the land, though the water temperature changes very slightly over the former.

It would be impossible to give in a short space all the explanations that have been advanced for this phenomenon. Changes of temperature and moisture have been appealed to in vain. A potential effect has been suggested from the fact that there may be a re-action, as it were, from the air, owing to the increasing heat in the lower strata after sunrise. It is not too much to say that any and all explanations which ascribe this change in pressure to movements of any kind in the air, to a secondary effect from changes in temperature or moisture, and to any of the forces or agencies usually appealed to in atmospheric movements, have signally and utterly broken down. In 1881 J. Allan Brown (now deceased), after thoroughly examining this question, says (*Nature*, April 14, 1881), "If we suppose that the attraction of gravity is not the only attraction which affects the pressure of the atmosphere, but that this pressure varies through some other attracting force, such as an electric attraction of the sun depending upon the varying humidity of the air, and this again depending on its temperature, we should find another method of relating the two variations, which does not exist if gravitation alone is employed." In 1882 the present writer was called upon to give a course of twenty lectures upon meteorology before a class at Fort Myer, Va. In the nineteenth lecture of this course the remarkable similarity between the curves of diurnal range in air-pressure and of the declination magnet was pointed out, and a connection between these phenomena, as well as a common origin, were distinctly suggested (see *Annual Report of the Chief Signal Officer*, 1882, p. 142).

There has just come to hand an interesting paper on "Diurnal Variation of Terrestrial Magnetism," by Professor A. Shuster (*Philosophical Transactions of the Royal Society, London*, vol. 180, p. 509). I quote from the latter part of the paper.

"The late Professor Balfour Stewart has suggested that the earth's magnetic force might induce electric currents in the convection currents which flow in the upper regions of the atmosphere. One difficulty of this hypothesis was removed by an experimental investigation, by means of which I proved that the air can be thrown into a sensitive state in which small electro-motive forces will produce sensible electric currents. To bring the air into that sensitive state, it is only necessary to send an electric current through it from some independent source of high potential. It is very likely that the air in the upper regions of our atmosphere is in such a sensitive state; and it is quite possible, therefore, that the induced electric currents suggested by Professor Stewart really exist. In order that electric currents should be induced which could account for the observed movement of the magnetic needle, it is only necessary to imagine convection currents in the upper regions from east to west during certain parts of the day, and from west to east at other times. As regards the effect of the sun, we have, indeed, a daily period of the barometer which is probably due to thermal effects. It is curious and suggestive, that the horizontal motion which must accompany the change in pressure is just such as would account for the daily variation of the magnetic needle. In the tropics the principal minimum of the barometer takes place about 3.40 P.M., and the principal maximum about 9 A.M. According to the theory of waves, there would be a horizontal movement from west to east in the afternoon, and from east to west in the forenoon. The direction of the induced electric currents would be away from the equator in both hemispheres in the afternoon, and towards the equator in the forenoon. This is exactly the system of currents we have been led to, starting from the observed magnetic variation. The only difficulty I feel in suggesting that the cause of the diurnal variation of the magnetic needle is the diurnal variation of the barometer, lies in the fact that it would oblige us to place the electric currents into the lower regions of the atmosphere, as these only will be much affected by the thermal radiation of the sun."

I give four of Professor Shuster's conclusions.

"1. The principal part of the diurnal variation [of the needle] is due to causes outside the earth's surface, and probably to electric currents in our atmosphere.

"3. As regards the currents induced by the diurnal variation, the earth does not behave as a uniformly conducting sphere, but the upper layers must conduct less than the inner layers.

"4. The horizontal movements in the atmosphere which must accompany a tidal action of the sun or moon, or any periodic variation of the barometer such as is actually observed, would produce electric currents in the atmosphere, having magnetic effects similar in character to the observed variation.

"5. If the variation is actually produced by the suggested cause, the atmosphere must be in that sensitive state in which, according to the author's experiments, there is no lower limit to the electromotive force producing a current."

Meteorologists are now becoming somewhat accustomed to seeing suggestions from generally recognized authorities, showing the possibility of some kind of electric action taking place in the atmosphere, though I do not claim that this view is accepted as yet in any except an extremely limited sense as an explanation of atmospheric phenomena. I do not fully understand some of Professor Shuster's views. The expression "convection currents which flow" does not convey a definite meaning. Just how electric currents are to be induced in the upper air strata by a wave of heat is also not entirely plain. The expression "the horizontal motion which must accompany the change in pressure," as applied to the diurnal range of pressure, I think, simply means the horizontal propagation of a wave of pressure, and not any actual motion of air. I can hardly see how the convection currents of a thermal wave with the minimum point in the lower air strata at sunrise, and the maximum point about 3 P.M., can possibly induce electric currents having critical points at 10.30 A.M. and 3 P.M. It is generally accepted that the diurnal range of temperature in the free air is practically nothing at heights above five thousand feet; so that the supposed convection currents from the direct thermal effect cannot induce electric currents in the upper strata.

It seems to me there is also an objection to Dr. Hann's view, that the diurnal range of air-pressure can be due to the direct heat-action (*Wärmewirkung*) of the sun upon the upper limits of the atmosphere.

I have very recently discovered a method of studying the diurnal range of air-pressure and allied phenomena which seems capable of great extension, and possibly of displaying many important facts. For many years I have searched for a simple method of separating out the accidental variations of pressure, temperature, moisture, etc., in our atmosphere, produced by the progress of high and low areas, from those which are more or less constant in their action. It is quite well established that these highs and lows (called by many "anticyclones" and "cyclones") have a common progression from west to east, especially in this country. The plan proposed is to carry back the conditions observed at any moment in the atmosphere to a point of time several hours before, say twelve hours, or especially twenty-four hours. This becomes a simple matter when we have a regular advance in a high or low; for we can place its centre at the point where it was twelve or twenty-four hours previously, and then at once read off the amount of change at each station for either of those intervals of time. During the month of August, 1890, I had occasion to try this method for determining the diurnal range of air-pressure from 8 A.M. to 8 P.M., and *vice versa*; and the results were of the highest interest. For example: on Aug. 6, at 8 P.M. there was a fall in pressure in twelve hours of from one tenth to two-tenths of an inch from the Atlantic to the 107th meridian. The next morning there was almost a complete recovery over this region. On the 8th in the morning there was a rise of from one-tenth to two-tenths of an inch over the whole, and at 8 P.M. of the same day there was a fall of one tenth of an inch over half, the above region. I found the general tendency for this diurnal range in air-pressure to be the same for both highs and lows, though the fall is generally slightly greater in the low, and *vice versa* in the high. It should be noted that this diurnal range was often obliterated, or even carried in an opposite direction, in some parts of the country

when it was impossible to centre exactly the two maps. There was a law, however, showing a marked general rise in pressure in the forenoon, and a corresponding fall in the afternoon. This may be seen to be all the more remarkable, since the observations were made at 8 A.M. and 8 P.M., 75th meridian time, and not at 10.30 A.M. and 3 P.M., which are the maximum and minimum points in the diurnal range. We see that these changes in air-pressure are not due to the advance of any air-wave or of air-particles, for this would imply a velocity of over two hundred miles an hour for this region alone. The rise in pressure in the forenoon cannot be due to an inflow of air from surrounding regions, because the rise occurs over all the surrounding region. It seems impossible to consider that any direct thermal effect can do more than simply heat the air without changing its pressure. It seems to me we are driven to the hypothesis that these changes are brought about by some agency outside of the earth. Is it incredible to suppose that there is a thermo-electric action from the sun upon the atmosphere propagated like a wave one thousand miles per hour, which is the principal cause of the diurnal range of both the magnetic needle and of air-pressure, and upon which other effects may be superposed?

H. A. HAZEN.

Washington, Oct. 18.

Origin of Right or Left Handedness.

THE question of the nature and origin of right or left handedness has given rise to much discussion in late years, the conviction growing among investigators that it is due to some hidden difference in the structure or function of the two hemispheres of the brain. The best *résumé* and general discussion of the question is the learned monograph by Sir Daniel Wilson entitled "The Right Hand and Left-handedness," being a reprint from the "Transactions of the Royal Society of Canada," Section II., 1886.

In order to examine more particularly into the time at which the child begins to show signs of marked preference for either hand, I instituted a series of experiments upon my own child, extending them over the greater part of the first year. As I have no time at present to write up the results systematically, I wish simply to announce a point or two which may be of interest to students of the subject.

1. I found no trace of preference for either hand as long as there were no violent muscular exertions made (based on 2,187 systematic experiments in cases of free movement of hands near the body: i.e., right hand 585 cases, left hand 568 cases, a difference of 17 cases; both hands 1,034 cases; the difference of 17 cases being too slight to have meaning).

2. Under the same conditions the tendency to use both hands together was about double the tendency to use either (seen from the number of cases of the use of both hands in the statistics given above), the period covered being from the child's sixth to her tenth month inclusive.

3. A distinct preference for the right hand in violent efforts in reaching became noticeable in the seventh and eighth months. Experiments during the eighth month on this cue gave, in 80 cases, right hand 74 cases, left hand 5 cases, both hands 1 case. In many cases the left hand followed slowly upon the lead of the right. Under the stimulus of bright colors, from 86 cases, 84 were right-hand cases, and 2 left-hand. Right-handedness had accordingly developed under pressure of muscular effort.

4. Up to this time the child had not learned to stand or to creep: hence the development of one hand more than the other is not due to differences in weight between the two longitudinal halves of the body. As she had not learned to speak or to utter articulate sounds with much distinctness, we may say also that right or left handedness may develop while the motor speech centre is not yet functioning.

Other points resulting incidentally are of interest in general psychology: i.e.,—

5. At the end of the seventh month the child's visual estimation of distance was exact enough to lead her invariably to refuse to reach for an object more than fourteen inches distant, her reaching distance being from nine to ten inches (based on tabulated experiments). Moderate stimuli she refused beyond thirteen inches.

6. Of the five colors, blue, red, green, brown, white, blue and red were most attractive, and about equally so, as measured in terms of voluntary exertion in reaching for them.

7. The fact mentioned above under Paragraph 3 furnishes another item of evidence for the presence of efferent feelings of innervation. Why did the child prefer the right hand uniformly for effort, if not under the feeling of stronger outward nervous pressure in the case of that hand? Professor James, no doubt, can explain it with his "kinaesthetic memories,"—that sword with which he decapitates so many points of evidence in his "Principles of Psychology,"—but he does not succeed in convincing many of us, any more than Bastian did in the first place. If memories of former movements with effort give "the cue," then how do you know that there are no memories of "innervation" among them? But memories of movement without effort cannot give the "cue," for my child used both hands equally in movements without effort; and the motor force of such memories would be neutral as regards hand-preference. How simple the explanation from the point of view of "innervation"! Memories of effortless movement are all of efferent sensations: hence either hand responds, or both. Memories of movements with effort are the same memories plus memory of an afferent feeling of effort: hence the right hand moves, perhaps followed by the left; that is, a memory of feeling of innervation in former cases is re-enforced by the same feeling now. Perhaps Professor James or some other "afferentist" will explain this case. The child is now (thirteenth month) a confirmed right-hander, so to speak.

I have cited only points which have their own value,—points on which observations on one child are as valuable as on many,—determinations concerning the order of development of the mental functions with the physical, not determinations merely of the time of development, which may vary. Observations on single children may also be valuable as showing that an event may happen, as opposed to theories according to which such an event may not happen, under given circumstances.

J. MARK BALDWIN.

University of Toronto, Oct. 18.

Deaf-Mutes.

PROFESSOR ALEXANDER GRAHAM BELL, in a recent number of *Science* (Sept. 5) correctly quotes me as saying, "I do not discourage the intermarriages of the deaf, as they are usually more happily mated thus than where one of the parties only is deaf. The deaf need the companionship of married life more than those who hear, and it is a gross wrong to discourage it." And he adds the following statement and inquiry: "Dr. Gillett is probably the oldest teacher in America,—not oldest in years, but oldest in service,—and he is looked up to as a guide by very many in the profession. Much good might arise from a comparison of views between Dr. Gillett and those scientific gentlemen who have given most attention to the subject of heredity. May I ask him, through the columns of *Science*, what would be his advice in such a case as the following? A young man (not a deaf-mute) became deaf in childhood while attending public school. He has one brother who is a deaf-mute, and another who can hear. Two others of the family (believed to be hearing) died young. The father of this young man was born deaf in one ear, and lost the hearing of the other subsequently from illness. He had a congenitally deaf brother who married a congenital deaf-mute and had four children (three of them congenital deaf-mutes). The mother of the young man was a congenital deaf-mute, and she also had a brother born deaf. The paternal grandmother of the young man was a congenital deaf-mute, and she had a brother who was born deaf. This brother married a congenital deaf-mute, and had one son born deaf. The great-grandfather of this young man (father of his paternal grandmother) was a congenital deaf-mute; and he was, so far as known, the first deaf-mute in the family. Thus deafness has come down to this young man through four successive generations, and he now wants to marry a congenital deaf-mute. The young lady has seven hearing brothers and sisters, and there was no deafness in her ancestry, but she herself is believed by her family to have been born deaf. Dr. Gillett must

not think that this is a purely hypothetical case, for it is not. The parties are engaged, but the marriage has not yet been consummated, and I know that Dr. Gillett's advice would have weight with the young people. The teacher of the young lady has been consulted, and she feels the responsibility deeply. Her heart is with the young couple, and she desires their happiness, and yet her judgment is opposed to the union. Will Dr. Gillett tell us what his advice would be in such a case?"

My advice in such a case as this would be for the young people to examine themselves carefully as to what their motives are in contemplating matrimony. If they have no higher thought than the animal impulse, I would advise them by no means to enter into that sacred relation; but if they are already so united in heart that each is needful to the happiness of the other, I would advise them as soon as their circumstances are such as to enable them to maintain a family in comfort, whether the children should hear or be deaf, to follow the promptings of their higher nature, with a determination to rear their children to respectability and usefulness, which they can do in one case almost as effectually as in the other. Thus one happy union will certainly be effected; while, if prevented, not only would this be estopped, but probably two unhappy, because uncongenial, ones would ensue. If deafness were a crime, or a disgrace, or entailed suffering, I would certainly discourage it; but since it does not, I deem it wise to encourage such a marriage, if the parties most interested believe, after reflection, that their own happiness will be promoted thereby.

That there are some deaf persons sprung from deaf parents is admitted, but their number is very small. There has been much discussion of late years about the advisability of deaf-mutes marrying, lest the infirmity of deafness may descend to their offspring, and a deaf variety of the human race be formed. Until a few sparrows will make spring, this hobgoblin will never materialize. Deafness is not continued by hereditary transmission in a direct line, except in rare instances. Not two per cent of the deaf and dumb are the children of deaf parents, though it cannot be denied that a susceptibility to the infirmity inheres in certain kindreds; so that we find it true, that, while a deaf pair seldom have deaf children, they have numerous other relations—as uncles; aunts; first, second, and third cousins; nephews; and nieces—who are thus afflicted. Hence, if some philanthropist is more concerned for the happiness of those who as yet are not, and may never be, than of those who now are and will for years continue with us, let him not discourage the marriage of those who are deaf, but that of their kinsmen; as, these being able to hear, and having all social advantages, the deprivation will not be so serious a matter to them as to their deaf relatives. The truth of this matter is, that, after laying all maudlin sentiment aside, there is no other class of people who so greatly need the companionship of the conjugal relation as the deaf and dumb. Shut out from church privileges, as preaching of the Word, prayer-meetings, socials, receptions, lectures, concerts, parties, what remains to them of all that makes life pleasurable to us? The deprivation of their hearing has not diminished their social instincts. For companionship, family ties, and festive associations, they have as strong affinities as any one. The isolation caused by deafness, I believe, makes the marital impulse stronger in them than in others. To forbid them, as some would, matrimony, the one remaining but most helpful and enjoyable of all social and family relations, is a monstrous cruelty with very little reason. For these reasons, after many years of observation, in which I have known hundreds of instances of deaf-mute unions, and after closely studying my more than two thousand pupils, one of my highest pleasures and satisfactions is to see them judiciously and happily mated in the conjugal relation. For the foregoing reasons I have long approved, and still do, of the marriage of the deaf; and I believe that, as a general rule, their intermarriage is more congenial, and productive of more happiness, than the marriage of deaf with hearing persons, though I have known most beautiful and happy unions of the latter kind. "Be ye not unequally yoked together," is a Scripture injunction that bears with as much force upon the deaf as upon any others. That it would be possible in process of time to generate families who would all be deaf, I fully believe.

If the object of matrimony was only to produce human animals, irrespective of their mental and spiritual nature, I should advocate the prevention of the marriage not only of the deaf, but of some other classes who labor under physical defects. But this is not the case. A true marriage is upon a higher and holier basis than this. Its essential element is in the affections of a pair whose perfect union is necessary to their happiness. The happiness of this pair I believe to be of more consequence to themselves and to society than the possible or even probable inconvenience of their offspring. I say inconvenience, for deafness is neither a crime nor a disgrace; nor does it inflict any suffering on its subject. There was a time when the deaf were considered but brutes, and classed as idiots, and treated accordingly. That time, all are thankful, is past; and in our time deaf persons often stand in society the peers of any others, in all that makes true nobility of character and manhood. In education, in mechanical skill, in æsthetic culture, in artistic talent, in true refinement and taste, they are oftentimes above the average of hearing people; and sometimes the deaf member of the family is the one of all his kindred most entitled to respect, because his deafness, having withdrawn him from his surroundings, has placed within his reach an education and culture that enables him to live on a much higher plane than any of his relations enjoy, and than he would have enjoyed if he had not been deaf. There is in society a vast amount of practical ignorance concerning the deaf, which it seems almost impossible to eradicate. This is one of the heritages handed down from former times, when deafness was indeed a great calamity, consigning its subject to perpetual infancy in law, and to dense ignorance for life. But, as already stated, times have changed; and what was once a calamity is now only a serious inconvenience. There are other inconveniences that descend by heredity that we might quite as well combat through matrimony as deafness. Baldness is a physical defect that is often (in fly-time and in cold weather, or when sitting in a draught, for instance) a great inconvenience; but who ever thought of classing the bald-headed among the defective classes, or of regarding baldness as a crime or disgrace? Near-sightedness is a physical defect that is often very inconvenient; but who ever thought to trace the pedigree of bald or near-sighted people, to see if they might enter into wedlock?

PHILIP G. GILLET.

Jacksonville, Ill., Oct. 22.

Chalk from the Niobrara Cretaceous of Kansas.

THE chalk from the Niobrara cretaceous of Kansas has long been known, but, so far as I am aware, little has been hitherto discovered regarding its structure or formation. Professor Patrick, some years ago, stated that it contained no microscopic organisms, but afterwards, with the aid of a very high power objective, found what he thought were organic remains. This is all the more remarkable, as the chalk appears to be wholly composed of organic forms, very readily visible under a comparatively low power (a one-fifth or a one-sixth objective and a C eye-piece). A ready way to detect them is by allowing a thin film held in suspension in water to dry on a slide, afterward mounting in balsam. I have examined a number of specimens, and find the material composed of small elliptical disks, either with four depressions or foramina, leaving ridges in the shape of a Greek cross, or with one or two central depressions or nuclei. Scattered among them are small slender rods, and occasionally a number of these were seen attached to a central mass. I believe the disks to be coccoliths (discoliths), which occur abundantly in the white chalk of England, and, at the present day, in deep-sea deposits. The Kansas chalk, however, has always been thought to be a shallow-sea deposit,—a belief strengthened by the abundance of thick-shelled molluscan remains, such as certain *Inocerami*, *Rudistes*, etc. The Kansas chalk, unlike the English, shows no flinty nodules. I shall make further examinations of material from different regions of the outcrop, which varies not a little in its physical and fossiliferous characters, and publish further results of my investigations, with figures.

S. W. WILLISTON.

University of Kansas, Oct. 24.

AMONG THE PUBLISHERS.

THE Forest and Stream Publishing Company of New York will issue at once the first number of a quarterly publication entitled "The Book of the Game-Laws," compiled by the editor of *Forest and Stream*, and containing all the laws of the United States and Canada relating to game and fish.

—Messrs. John Wiley & Sons announce for immediate publication Egleston's "Metallurgy," Vol. II.

—D. C. Heath & Co. have in active preparation for early publication "The American Citizen," by Rev. Charles F. Dole. It is intended to provide a book suitable for the higher grades of the grammar-school, as well as for high-schools and academies.

—The Goldthwaite Geographical Exchange, New York, has brought out a new edition, based on the 1890 census, of "Cram's Standard American Atlas." Special attention is given in this atlas to the railway systems, which are printed in separate colors. The index is claimed to be very complete, giving not only the location of the places, but also the means of reaching them by rail, express, etc., and the banking facilities available.

—Messrs. D. C. Heath & Co., Boston, have in preparation the following additions to their valuable list of works on education: (1) the authorized translation of Compayré's "Psychologie Appliquée à l'Éducation," in two volumes,—Vol. I., "Notions Théorétiques," a treatise on elementary psychology; Vol. II., "Application," a practical application of the principles of psychology to physical, intellectual, and moral education; and (2) the authorized translation of Compayré's "Cours de Morale Théorique et Pratique." These lectures are all fully indexed, and each is followed by a *résumé* of its contents.

—Three new Old South Leaflets have been added to the general series published by D. C. Heath & Co., all of them devoted to Indian subjects. The first is Coronado's "Letter to Mendoza in 1540," written probably from the Zuñi pueblo, describing his search through New Mexico for the famous "Seven Cities of Cibola." This English translation of Coronado's report has never been published before except in the large and costly collection of Hakluyt; and it is of special interest at this time, when the researches of Frank Cushing and others have directed attention anew to the Zuñi country. The other two leaflets are John Eliot's "Brief Narrative of the Progress of the Gospel Amongst the Indians of New England," first printed in London in 1671, and Rev. Eleazer Wheelock's "Narrative of the Original Design, Rise, Progress, and Present State of the Indian Charity-School in Lebanon, Conn." (1762). The establishment of this school was the most important and interesting effort for the education of the Indians in New England, in the last century; Dartmouth College, of which Wheelock was the first president, being an outgrowth of the school. These papers are a valuable addition to the series of Old South Leaflets, which now furnishes so many original historical documents to our students at the cost of a few cents, Wheelock's "Narrative" being No. 22 of the series. Mr. Mead's historical and bibliographical notes to the three new leaflets are full.

—The result of the experiments at the Ohio State Agricultural Station in the cultivation of different varieties of strawberries shows that if we separate varieties of strawberries into two classes,—viz., those that continue a long time in bearing, and those that have a short season,—we find that the most prolific fall into the first class, while those that give small crops continue but a short time in bearing; in other words, those that give the greatest number of pickings during the season produce the largest crops. It might seem that the aggregate crop would depend as much, or more, upon the quantity of fruit ripe at each picking, as upon the number of pickings; it would also seem that the varieties that ripen slowly, and continue a long time in bearing, would be more in danger of dry weather than those that yield their crop in a short time: but such does not appear to be the fact. Nearly all of the very early varieties continue but a short time in bearing, yield but few pickings, and give short crops. The same is true, in a more marked degree, of the extreme late sorts. They commence to ripen late, but hold out little, if any, longer than the medium varieties. The second early or medium varieties usually give more

pickings during the season, and continue longer in bearing, than the extreme early and late sorts, hence give a greater total yield. Those varieties of strawberries that produce pollen and berries also, are at a disadvantage as compared with those that produce berries only. Division of labor counts here as elsewhere. Give a plant nothing to do but to grow and bear fruit, and the work will be better done than if an additional task is imposed. To produce pollen taxes the energies of the plant much more than is commonly supposed. Many growers think it would be desirable to have varieties with perfect blossoms only to save the trouble of planting the two classes. Theory disproves this plan; and careful observations show, that, in general, the most prolific sorts are those that have imperfect flowers. It should be understood that these statements refer to the leading varieties that are most generally grown. There are some apparent exceptions even with these, and still more if all known varieties are included.

—The November number of *The Sanitarian*, forthcoming, will begin the publication of the "Transactions of the American Climatological Association," held at Denver, Col., Sept. 2, 3, and 4, 1890. All new subscribers for *The Sanitarian* for 1891, sending their subscriptions before the 15th of November, will be supplied with the November and December numbers gratis. All correspondence should be addressed to the editor, A. N. Bell, M.D., 113a Second Place, Brooklyn, N.Y.

—Mr. Edward L. Wilson, who has travelled extensively through the Holy Land with notebook and camera, is about to publish the results of his wanderings in a work entitled "In Scripture Lands." It is to be issued at an early date by the Scribners. A new work of practical value, entitled "Electricity in Daily Life," is also about to be published by them. It is a popular account of the application of electricity to every-day uses. The various branches of the work have been intrusted to writers selected for their expert acquaintance with the subject. A life of John Ericsson will

be published immediately by the same firm. It is written by Col. Church, who was intimately acquainted with Ericsson for many years, and has been intrusted with the famous inventor's papers and correspondence. It will be profusely illustrated. They have already issued new and cheaper editions of Schuyler's "Peter the Great" and Professor Shaler's "Aspects of the Earth."

—*Public Opinion*, the eclectic weekly published in Washington and New York, offers a first prize of \$50, a second of \$30, and a third of \$20, for the best three essays on the interesting question "The Industrial Future of the South." The essays must be limited to 3,000 words, and must be received by Dec. 15. Full particulars may be had by addressing *Public Opinion*, Washington, D.C.

—The *Nineteenth Century* for October opens with a symposium on "The Labor Revolution," by H. H. Champion, T. R. Threlfall, and Hon. R. B. Brett. Mr. Champion's paper is entitled "A Multitude of Counsellors;" Mr. Threlfall, who is secretary to the Labor Electoral Association of Great Britain and Ireland, discusses the new departures in trades-unionism; and Mr. Brett raises the question as to what are the ideals of the masses. His Excellency Sir Henry A. Blake, governor of Jamaica, contributes a paper on "The Awakening of Jamaica," in which he discusses the past and present economical history of the island, and the latest attempts to revive its resources; D. Henry Behrends points out the dangers of tuberculous meat and its consequences; Wilfrid Ward gently and sympathetically touches on some aspects of Newman's influence; Hamilton Aide describes manners and customs in Sicily in 1890; the Bishop of Carlisle writes on "Bees and Darwinism," and defends himself against an attack of Professor Romanes; Arthur P. Crouch discusses the relations between Dahomey and the French; Miss Benson comes to the defence of domestic service; B. Paul Neuman and the Rev. Herbert Darlow examine the weaknesses of Congregationalism, the former from the pews, the latter

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TO AUTHORS.

Correspondence is solicited with parties seeking publishers for scientific books.

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from the pulpit; J. Aratoon Malcolm presents a plea for Armenia in a paper entitled "Armenians' Cry for Armenia;" Louis J. Jennings describes the imperfections in the English civil service as illustrated in the admiralty; and the number closes with an article on "Meddling with Hindoo Marriages," by J. D. Roos.

—The recent death of Canon Liddon will furnish the theme of many an article *in memoriam*, and the *Reviews* are already printing tributes to the memory of the great English preacher. Canon Scott Holland opens the *Contemporary Review* for October with a brief but sympathetic notice of the life and work of his friend; Sir Morell Mackenzie writes at some length on "The Use and Abuse of Hospitals," and makes many suggestions that are of value; Sir Dr. William Wright takes up the forward movement in China, giving his attention to the progress of missions and the conditions they have to contend with; Sir T. H. Farrer discusses imperial finance of the last four years in the first of a series of papers on recent English financial methods; A. Taylor Innes writes on "Standpoint of the English Law;" Michael G. Mulhall points out the possibilities of naval warfare; Mr. Justice O'Hagan tells the story of the life of Thomas Davis as an illustration of Irish patriotism; and Dr. F. H. Geffcken contributes a thoughtful paper on "The Economic Condition of Italy." The more strictly literary portion of the number is to be found in the first part of a story by Vernon Lee, entitled "A Worldly Woman."

—"The Problems of Greater Britain," based on Sir Charles Dilke's famous work, forms the opening paper in the *Westminster Review* for October; Ernest A. Vizetelly concludes his papers on Paoli the Patriot; Jeannie Lockett makes a valuable contribution to the divorce question in an article on "Clerical Opposition to Divorce in Australia;" T. W. Rolleston tells the story of the Irish Parliament and its struggle for reform in 1782-93; Frances Russell contributes a brief and suggestive paper on "Neglected Path to Greatness;" Mr. George C. Call describes the search for the lost

Mr. Bathurst, whose disappearance in the early part of the century has never been accounted for; Alice Bodington writes on "The Importance of Race and its Bearing on the Negro Question;" and the number concludes with the usual review of the English politics, and the department of "Contemporary Literature," reviews of the latest books,—a feature of the *Westminster* which has just been revived, and which was once its strongest part.

—A new and revised edition of Jesse R. Macy's work on "Our Government" has appeared from the press of Ginn & Co. It has always been deemed one of the best works of the kind, and the author has endeavored to improve on the original edition in accordance with the lessons of experience. Mr. Macy's style of expression has no great literary finish, but is plain and easily intelligible. The work is very condensed, and the student cannot read it in a hurry; but this condensation enables it to convey a great deal of information in a small space. It treats the whole subject of governmental agencies, national, state, and municipal—treats it, for the most part, well. One of the best parts of the book relates to the administration of justice,—a subject that is apt to be neglected in such works, but which is more important than any other. Mr. Macy has given his chief attention to description, and yet a good deal of information as to the purpose and uses of government is incidentally conveyed. The book deserves its reputation, and we hope will continue to be widely used.

—The October number of the *Fortnightly Review* contains the first parts of two new novels,—one by Count Leo Tolstoi, entitled "Work while You have Light," a tale of the early Christians; the other by George Meredith, entitled "One of Our Conquerors." Both these novels are highly characteristic of their authors, and are destined to attract wide attention. The general articles of the *Review* suffer no diminution through the introduction of the new element and its development from the standpoint of a resident. The series of papers on "Modern Russia," by E. B. Lanin,

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which have been an important feature of the *Fortnightly* for some months past, approach a conclusion in an article on "Jews in Russia." Sir Frederick Pollock writes on John Milton; Miss M. Dewie contributes a readable paper entitled "In Ruthenia," dealing with a province of Poland that is almost unknown to the general tourist, but which possesses many points of interest; A.

Egmont Hake and O. E. Wesslau discuss the American tariff war; there is a suggestive paper on "Reason and Religion;" A. Symons Eccles criticises the results of the Tenth International Medical Congress; George Moore criticises the new pictures in the National Gallery; and George Saintsbury sketches the life and works of Anthony Hamilton.

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